

only unknown, and that approximate values of the true solar parallax and of the errors of R.A. and N.P.D. should be substituted in the equations. This was done, the mean solar parallax being taken at  $8''.85$ ,  $d$  R.A. as  $+5''.81$ ,  $d$  N.P.D. as  $-5''.33$ , which values resulted from the general solution of the whole of the contact observations, and the following values of  $dR + dr$  were obtained:—

Station.	By Burton's Measures.	Number of Photographs Measured.	By Tupman's Measures.	Number of Photographs Measured.
Luxor ... ..	$-0''.96$	11	$-0''.13$	12
"	$-1''.18$	11	$-1''.61$	11
"	$-2''.21$	11	—	—
Honolulu ... ..	$-1''.29$	11	$-0''.21$	12
"	$-1''.75$	11	$-0''.54$	12
"	$-0''.71$	10	—	—
Rodriguez ... ..	$+1''.19$	11	$+2''.44$	9
"	$+0''.23$	10	$+2''.49$	6
"	$+2''.10$	10	$+2''.74$	8
"	$+0''.14$	11	$+1''.27$	10
"	$+1''.46$	11	$+2''.31$	9
Burnham, N.Z....	$+0''.68$	13	$\begin{cases} +1''.89 \\ +1''.38 \end{cases}$	$\begin{matrix} 3 \\ 10 \end{matrix}$
Kerguelen ... ..	$+1''.51$	8	—	0

The above is perhaps the best way to exhibit the nature of the discordances. They might also have been shown as apparent errors of the tabular distance of centres.

The discordances of any one station are too large to admit of the measures being employed with advantage for the determination of the solar parallax. They are due to inherent defects of the photographic images. The reason why at the two northern stations the signs are all *minus*, while at the three southern they are all *plus*, is at present obscure, and I am not prepared to offer any suggestion as to the cause.

#### THE NORWEGIAN NORTH ATLANTIC EXPEDITION

I SEND you inclosed a clip from the *Dagbladet*, containing the route of our expedition for the coming summer. I hope to be able to send you notes from our expedition during our several stays in Hammerfest.

H. MOHN

"According to the plan of this expedition, the *Voeringen* was to start from Bergen on its third and last cruise on the 15th inst. It will probably have reached Tromsøe by the 19th inst., and, after taking on board a pilot acquainted with the northern waters, have immediately proceeded to Alten Fiord, mainly to inspect the meteorological station there; and to examine the animal and plant-life of the Fiord bottom. The magnetic observations required for regulating the compasses, &c., were to be made at Hammerfest between the 21st and 24th inst. The course was then to be set eastwards, in order to examine the relations of depth and animal life, &c., in two of the fiords of Finmark. After touching at Vardoe on the 27th, the voyage is to be continued to a point midway between Vardoe and Novaya Zemlya, in order to take soundings and determine the boundary of the ice-cold

water in the East Polar Sea, which hitherto in these regions has only been observed at Bear Island by the well-known Austrian Polar explorer Weyprecht, in his excursion thither several years ago in the Tromsøe yacht *Samson*. This thorough examination of the sea off the north-east coast of Norway, towards Novaya Zemlya will be of special importance for the study of the migrations of the "lodde" (*Malotus arcticus*), as it is probable that it is there that this salmon-like fish has its abode whence in spring it makes its way in large shoals to the coast of Finmark to spawn, pursued by the cod, which follows it and is accordingly taken; while the so-called "lodde" fish, as is well known, is not fished for, because it is not suitable for human food, on account of its penetrating unpleasant odour.

This eastward cruise of the *Voeringen* will scarcely occupy more than ten days, as the sea is here so shallow that taking soundings, &c., need not occupy much time, and the *Voeringen* may accordingly be expected back at Hammerfest on July 7, to take on board coal, water, &c., for a new cruise to the westward in the navigable waters north of Jan Mayen, which the expedition visited last year; thence to the Greenland ice, where the seal fishing is usually carried on, in order to ascertain the boundary between the Greenland Polar current and the Gulf Stream. The stretch of sea that will be traversed by the *Voeringen* has not hitherto been surveyed, and here will doubtless be found, by means of the lead, the beginning of the great Polar sea-depth which runs in between Greenland and Spitzbergen. The *Voeringen* will then return to Hammerfest to make preparations for the third cruise.

This cruise, which will be the last, will be commenced on July 29, and be occupied with the survey of the navigable waters between Bear Island and Spitzbergen, where the well-known shark fishing is prosecuted, and the great sea-deeps off the west coast of Spitzbergen ( $76^{\circ}$  to  $80^{\circ}$  N. lat.) which hitherto have only been surveyed, and that incompletely, by two of the Swedish expeditions. The *Voeringen* will go as far north as it can for ice, but there is certainly no great expectation that the Norwegian expedition will be successful in carrying off the prize in the competition with other nations to reach the North Pole, for the *Voeringen* will certainly soon meet with ice in the navigable waters on the north coast of Spitzbergen, and it is not fitted out for a North Pole expedition. Leaving it to the enterprising publisher of the *New York Herald* and others to endeavour to reach this goal, the *Voeringen* will, instead, after having turned southwards, survey the fiords and banks on the west coast of Spitzbergen. There the Norwegian fishermen, as is well known, carry on a not inconsiderable cod-fishing, the yearly catch numbering 300,000 to 400,000 fish. But if we keep in view the recent discovery of the great fishing bank off the Lofoten Islands, it will be seen that the fishermen need not undertake the long and troublesome voyage to Spitzbergen to catch cod. They will find superabundance of larger and better fish at the banks off Vesteraalen, so to speak, lying before their own door. But these Lofoten fishing banks are for the time being visited by the Norwegian fishermen as little as the bank abounding in fish which lies off the Froey Islands (north-west of the mouth of Trondhjem Fiord), although the latter was known to old fishermen. The surveying-steamers *Hausteen* has now mapped it. It is besides beyond all doubt that one of the practical results of the Norwegian North Atlantic Expeditions will be a better turning to account of the rich fishing banks of whose position, animal and plant life, more precise information has now been obtained.

The return from Spitzbergen will take place at the end of August, and the *Voeringen*, after having touched at Hammerfest or Tromsøe, and Bergen, where the members of the expedition resident there will land will

probably resume its course in the middle of September, terminate its voyage in the harbour of Horten."

The members of the expedition are the same this year as last, viz., Profs. Dr. H. Mohn, meteorologist; Dr. G. D. Sars, Dr. Danielssen, and Herr H. Friele, zoologists; candidate Tornøe, chemist; assistant-candidate Schmelck, physicist and chemist; and the landscape-painter Herr Schiertz, as artist. The *Voeringen* will be commanded this year, as formerly, by Capt. Wille of the Royal (Norwegian) Navy, the second in command being the sailing-master, Capt. Greig. The expedition carries with it several valuable new instruments for measuring more exactly the temperature of the water at great depths; some of them have, with great good will, been obtained from the members of the English *Challenger* expedition. As in the preceding years, Prof. H. Mohn will send to NATURE communications from the expedition.

# PHYSICAL SCIENCE FOR ARTISTS<sup>1</sup>

## VI.

THE diagrams given in my last article should have made it quite clear that the various sunset and sunrise colours are due to the absorption produced by different thicknesses of aqueous vapour; that the colours of clouds are due to light falling upon them after absorption by different thicknesses of aqueous vapour; and finally that the blue colour of the sky in the zenith is due to the fact that the pure gases in our atmosphere exist in that molecular grouping which vibrates in harmony with the short waves of light.

The blue sky, however, is scarcely ever a true blue. Between us and it there is ever a misty veil which reflects to us the white light of the sun, as an examination of it by a pocket spectroscope will prove to anybody. It is to the variation in the quantity of this misty veil that the difference in the colour in the sky at great and low elevations, in different climates, and in the same climate, when clouds are about to form and when scarcely the germs of clouds are present, is to be ascribed. The thickness of our atmosphere is so moderate that neither the hypothetical red nor the blue molecules of aqueous vapour are competent, except during thunderstorms, to influence its colour as they undoubtedly do near the horizon.

A glance at Fig. 4 in the last article will explain how it is that sometimes in the case of clouds we find the before-stated order of sunset colours reversed. If, for instance, we imagine a cloud lying along the curve  $xs'$ , an observer at  $o$  will see a cloud at  $x$  higher above the horizon than one at  $s'$ , but the cloud at  $x$  will have received light through a greater thickness of atmosphere than the cloud at  $s'$ . The red, therefore, at  $x$  will be more *foncé* than at  $s'$ ; the order of colour, though not of brilliancy, will be reversed.

So far we have considered these colours looking towards the rising or setting sun. Let us now turn our back on that luminary. It will be at once obvious that if, for instance, we take a point on the horizon, there will be an enormous increase in the thickness of atmosphere traversed by the ray; indeed, we may say that for this point the absorption will be threefold. Hence a considerable reduction of light, a ruddier tinge, due to the increased absorption of the more complex molecules, and a mingling of the ruddier light with the blue sky.

In the voyage which I made to India in 1871 I scarcely ever missed a sunrise or a sunset, and although the point of sunrise or sunset was almost always the scene of a succession of glories unsurpassed in beauty, the point opposite was, if possible, more interesting, the colours were more subdued, and of a more composite order, but

the work of law went on there, as elsewhere. If any clouds happened to be overhead, their greatest glory, which, as I have already shown, can only be put on when the sun is below the horizon—and the sun rises or sinks much more rapidly there than with us—was the herald of the shadow of the earth on the illuminated sky, which crept on a gigantic, mysterious crescent. That the shadow of the earth could thus be seen was new to me, and I am the more glad, therefore, seeing that many may doubt it still, to substantiate my observation and its explanation by a quotation from Prof. Brücke, one of the most distinguished members of the Vienna University. Prof. Brücke has been doing on the Continent what I have been attempting to do in these articles, and just before my last one appeared I saw in *La Revue Scientifique* an extract from his forthcoming work "Principes Scientifiques des Beaux Arts." I am delighted to see how much at one we are, but for the moment I shall content myself by giving what he says on the point to which I have referred. Talking of sunset he writes:—

"We see on the horizon to the east a grey blue stratum rising higher and higher, and stopping at that portion of the sky coloured red: it is the shadow of the earth.

"The shadow of the earth must always encounter an unilluminated part of the atmosphere. As this shadow does not fall on a surface, but on a great number of particles spread abroad in space, it is material, that is to say, it has three dimensions, and we see it, foreshortened—in perspective.

"Sometimes the regions above it are divided in a radial direction into sectors, some of which are dark, like the shadow of the earth, others red. These resemble in the sky the rays of the aurora borealis, and often change their place and size; in French they are termed 'les rayons de crépuscule.' They are due to the fact that in the path of the solar rays there are masses of clouds which only give passage to isolated ones here and there, which make their presence felt by the luminous train which they leave among the particles of the atmosphere. Hence arise those red prismatic masses spread abroad in the air east and west. At the zenith we do not remark them, because the vision cuts across them, and the stratum of illuminated particles is not thick enough to render them sensible; but we see them painted on the eastern sky because we regard them obliquely in the sense of their length; we see them in perspective. By their nature and their mode of origin they do not differ from the beams which the setting sun throws between the intervals in the clouds, nor from those which it sometimes casts in the morning or afternoon through the clouds, when the peasants say that 'the sun is drawing water.' 'Voilà un bouillon qui chauffe.'"

This paragraph not only supports my view, but it opens up several very interesting points on which, if space permitted, there would be much to say; one or two words, however, must suffice.

The rifts to which Prof. Brücke has drawn attention do not always arise from clouds; in fact, they are not seen in their greatest vividness when they do. One evening I saw them thrown, in a perfectly cloudless sky (in fact, there had been no cloud all day), by the sky-line of Socotra, which island we had passed during the day, and which was below the horizon at the time. Capt. Parish, in command of the *Mirzapore*, to whom I appealed at the time, took the bearing of these rifts, which, in their sharpness and magnitude, were almost appalling, and put the question beyond all doubt.

With regard to the "sun drawing water," artists should note the absence of all colour and the radial direction of the beams, all meeting in the sun's place. For some reason or other many artists are not yet quite clear about this appearance, and compromise matters by making the beams look like a distant rain-shower. There are some notable examples of this in the South

<sup>1</sup> Continued from p. 157.